XXIV. *Propoſals for the Recovery of People apparently drowned.* *By* John Hunter, *Eſq. F. R. S.*

R. Mar. 21, 1776.

HAVING been requeſted by a principal member of the ſociety, lately eſtabliſhed for the recovery of perſons apparently drowned, to commit my thoughts on that ſubject to paper; I readily complied with his requeſt, hoping, that, although I have had no opportunities of making actual experiments upon drowned perſons, it might be in my power to throw ſome lights on a ſubject ſo cloſely connected with the inquiries which, for many years, have been my favourite buſineſs and amuſement. I therefore collected together my obſervations and experiments relative to the loſs and recovery of the actions of life, and ſhewed them to a Society of which I am a member; who approved of them as new and curious, and unanimouſly recommended their being ſubmitted to the judgement of this learned Body. The practice is new, and has furniſhed as yet few important and clear facts. If we judge of the queſtion by our general knowledge of the animal œconomy, I am afraid, it is ſo imperfectly underſtood, that our reaſoning from it alone could not be relied on: nevertheleſs, on a ſubject ſo intereſting to humanity, we muſt not be idle; we muſt throw out our obſervations, and reaſon as well as we can from

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from the few *data* we have, in hopes that the ſubject, thus put fairly into the hands of the publick, may in time, by their united endeavours, become perfectly underſtood.

I ſhall conſider an animal, apparently drowned, as not dead; but that only a ſuſpenſion of the actions of life has taken place. This, probably, is the caſe in the beginning of all violent deaths, except thoſe cauſed by lightning or electricity, by which abſolute death may be produced inſtantaneouſly.

How a blow on the ſtomach cauſes death I have not been able to aſcertain. In all thoſe caſes which have fallen under my obſervation, the concomitant circumſtances have been ſuch as alſo attend death cauſed by electricity; *viz.* a total and inſtantaneous privation of ſenſe and motion without convulſions, and conſequently without any ſucceeding rigor of muſcles, totally differing in theſe circumſtances from death, where the perſon is ſtruck ſenſeleſs by any injury done to the brain. I ſhould conſider the ſituation of a perſon drowned to be ſimilar to that of a perſon in a trance. In both the action of life is ſuſpended, without the power being deſtroyed; but I am inclined to believe, that a greater proportion of perſons recover from trances than from drowning; becauſe a trance is the natural effect of a diſpoſition in the perſon to have the action of life ſuſpended for a time; but drowning being produced by violence, the ſuſpenſion will more frequently laſt for ever, unleſs the power of life is rouſed to action by ſome applications of art. That I may more fully explain my ideas upon this ſubject, it will be neceſſary to ſtate ſome propoſitions.

Firſt, that ſo long as the animal retains the powers, though deprived of the action, of life, the cauſe of that privation may frequently be removed; but, when the powers of life are deſtroyed, the action ceaſes to be recoverable. Secondly, it is neceſſary to mention that I conſider part of the living principle as inherent in the blood(a). The laſt propoſition I have to eſtabliſh is, that the ſtomach ſympathizes with every part of an animal, and that every part ſympathizes with the ſtomach; therefore, whatever acts upon the ſtomach as a cordial, or rouſes its natural and healthy actions, and whatever affects it, ſo as to produce debility, has an immediate effect upon every part of the body. This ſympathy is ſtrongeſt with the vital parts. Beſides this univerſal ſympathy between the ſtomach and all parts of the body, there are peculiar ſympathies; for inſtance, the heart ſympathizes immediately with the lungs. If any thing is received into the lungs, which is a poiſon to animal life, ſuch as the volatile part in the burning of charcoal, volatile vitriolic acid, and many other well known ſubſtances, the motion of the heart immediately ceaſes, much ſooner than if the

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(a) That the living principle is inherent in the blood, is a doctrine which the nature of this paper will not allow me at preſent to diſcuſs; thus much, however, it may be proper to ſay, that it is founded on the reſults of many experiments. But it may be thought neceſſary here, to give a definition of what I call the living principle: ſo far as I have uſed that term in this paper, I mean, to expreſs that principle which preſerves the body from diſſolution with or without action, and is the cauſe of all its actions.

trachea had been tied; and from experiments it appears, that any thing ſalutary to life, applied to the lungs, will reſtore the heart's action after it has been at reſt ſome time.

I ſhall divide violent deaths into three kinds. Firſt, where only a ſtop is put to the action of life in the animal; not, however, by any irreparable injury to a vital part. If this action is not reſtored in a certain time, it will be irrecoverably loſt. The length of that time is ſubject to conſiderable variation; which probably depends on circumſtances, we are at preſent unacquainted with. The ſecond is, where an injury is done to a vital part: as, by taking away blood till the powers of action are loſt, by a wound or preſſure on the brain or ſpinal marrow; notwithſtanding which, there remains ſufficient life in the ſolids, if actions could be reſtored to the vital parts. The third is, where abſolute death inſtantly takes place in every part, which is often the caſe in ſtrokes of lightning; in the common method of killing eels, by throwing them on ſome hard ſubſtance, in ſuch manner as that the whole length of the animal ſhall receive the ſhock at the ſame inſtant; and, as I believe, by a blow on the ſtomach; in all which caſes the muſcles remain flexible(*b*).

(*b*) On the other hand, when an eel is killed by chopping it into a number of pieces, the powers of life are by thoſe means rouſed into action; and, as every part dies in that active ſtate, every part is found ſtiff after death. This explains the cuſtom of cutting fiſh into pieces while yet alive, in order to make them hard, uſually known by the name of crimping.

Now, the preſent conſideration is, which of the kinds of violent death drowning comes under? I think, it comes under the firſt; and upon that ground I ſhall conſider the ſubject.

The loſs of motion in drowning ſeems to ariſe from the loſs of reſpiration, and the immediate effects which this has upon the other vital motions of the animal; at leaſt, this privation of breathing appears to be the firſt cauſe of the heart's motion ceaſing; therefore, moſt probably, the reſtoration of breathing is all that is neceſſary to reſtore the heart's motion: for if a ſufficiency of life ſtill exiſts to produce that effect, we may ſuppoſe every part equally ready to move the very inſtant in which the action of the heart takes place, their actions depending ſo much upon it. What makes it very probable, that the principal effect depends upon air being thrown into the lungs, is, that children in the birth, when too much time has been ſpent after the loſs of that life which is peculiar to the *fœtus*, loſe altogether the diſpoſition for the new life. In ſuch caſes there is a total ſuſpenſion of the actions of life, the child remains to all appearance dead, and would die, if air were not thrown into its lungs, and the firſt principle of action by theſe means reſtored. To put this in a ſtill clearer light, I will give the reſult of ſome experiments which I made, in the year 1755, upon a dog.

A pair of double bellows were provided, conſtructed in ſuch a manner as by one action to throw freſh air into the lungs, and by another to ſuck out again the air which had

had been thrown in by the former, without mixing them together. The muzzle of theſe bellows was fixed into the *trachea* of a dog, and by working them he was kept perfectly alive. While this artificial breathing was going on, I took off the *ſternum* of the dog, and expoſed the lungs and heart; the heart continued to act as before, only the frequency of its action was conſiderably increaſed. I then ſtopped the motion of the bellows, and the heart became gradually weaker, and leſs frequent in its contraction, till it left off moving altogether: by renewing my operation, the heart began again to move, at firſt very faintly, and with longer intermiſſions; but, by continuing the artificial breathing, the motion of the heart became again as frequent and as ſtrong as before. This proceſs I repeated upon the ſame dog ten times, ſometimes ſtopping for five, eight, or ten minutes. I obſerved, that, every time I left off working the bellows, the heart became extremely turgid with blood, and the blood in the left ſide became as dark as that in the right; which was not the caſe when the bellows were working. Theſe ſituations of the animal appear to me exactly ſimilar to drowning.

The loſs of life in drowned people has been accounted for, by ſuppoſing that the blood, damaged by want of the action of the air in reſpiration, is ſent, in that vitiated ſtate, to the brain and other vital parts; by which means the nerves loſe their effect upon the heart, and the heart in conſequence its motion. This, however, I am fully convinced is falſe: firſt, from the experiments on the dog, in whoſe caſe a large column of bad blood, *viz.* all that was contained in the heart and pulmonary veins, was puſhed forward, without any ill effect being produced; and next, from the recovery of drowned perſons and ſtill-born children, which, under thoſe circumſtances, never could happen, unleſs a change of the blood could take place in the brain, prior to the reſtoration of the heart's motion: therefore, the heart's motion muſt depend immediately upon the application of ſuch air to the lungs, and not upon the effects which air has upon the blood, and which that blood has upon the vital parts. Theſe are only ſecondary operations in the animal œconomy.

It frequently happens in the caſe of drowning, that aſſiſtance cannot be procured till a conſiderable time after the accident; every moment of which delay renders recovery more precarious, the chances of which are not only diminiſhed in the parts where the firſt powers of action principally reſide, but alſo in every other part of the body.

In offering my ſentiments on the method of treating people who are apparently drowned, I ſhall lay before you, firſt, what I would recommend to have done; ſecondly, what I would wiſh might be avoided.

When aſſiſtance is called in, ſoon after the immerſion, perhaps blowing air into the lungs may be ſufficient to effect a recovery (c). But if a conſiderable time, ſuch as an hour, has been loſt, it is moſt probable that this will not be ſufficient; the heart, in all likelyhood, will by this time have loſt its nice connection with the lungs. It will, therefore, be proper to apply ſtimulating medicines, ſuch as the vapour of volatile alkali, mixed with the air; which may eaſily be done, by holding ſpirits of hartshorn in a cup under the receiver of the bellows. I would adviſe the air and volatile alkali to be thrown in by the noſe, if by both noſtrils ſo much the better, as we know, that applications of this kind to the olfactory nerves rouſe the living principle, and put the muſcles of reſpiration into action, while ſome applications to the mouth rather depreſs than rouſe, by producing ſickneſs. If during this operation the *larynx* be gently preſſed againſt the *œſophagus* and ſpine, it will prevent the ſtomach and inteſtines being too much diſtended by the air, and leave room for the application of more effectual *ſtimuli* to thoſe parts. This preſſure, however, muſt be conducted with judgement and caution, ſo that the *trachea* and the aperture into the *larynx* may both be left perfectly free. While this buſineſs is going on, an aſſiſtant ſhould prepare bed-cloaths, carefully brought to the proper degree of heat. I conſider heat as congenial with the living principle; increaſing the neceſſity of action it increaſes action; cold, on the other hand, leſſens the neceſſity, and of courſe the action is diminiſhed; to a due proportion of heat, therefore, the living principle owes its vigour.

(c) Perhaps the dephlogiſticated air, deſcribed by Dr. PRIESTLEY, may prove more efficacious than common air. It is eaſily procured, and may be preſerved in bottles or bladders.

From obſervations and experiments it appears to be a law of nature in animal bodies, that the degree of heat ſhould bear a proportion to the quantity of life; as life is weakened, this proportion requires great accuracy, while greater powers of life allow it greater latitudes(d).

I was led to make theſe obſervations by attending to perſons who are froſt-bitten; the effect of cold, in this inſtance, is that of leſſening the living principle. The powers of action remain as perfect as ever, and heat is the only thing wanting to put theſe powers into action; yet this heat muſt at firſt be gradually applied, and proportioned to the quantity of the living principle; but, as life increaſes, you may increaſe the degree of heat. If this method is not obſerved, and too great a degree of heat is at firſt applied, the perſon or part loſes entirely the living principle, and mortification enſues. This proceſs invariably takes place with regard to men. The ſame thing, I am convinced, happens to other animals. If an eel, for inſtance, is expoſed to a degree of cold, ſufficiently intenſe to benumb him till the remainder of life in him is ſcarcely perceptible, keep him ſtill in a cold of about 40°, and this ſmall quantity of life will remain for a conſiderable time without diminution or increaſe; but, if he is put into about 60°, the animal will at firſt ſhew ſtrong ſigns of returning life, but will die in a few minutes. Nor is this circumſtance peculiar to the diminution of life by cold. The ſame *phænomena* take place in animals who have been very much reduced by hunger.

(d) It is upon theſe principles that cold air is found of ſo much ſervice to people who are much reduced by diſeaſe, as the confluent ſmall-pox, fevers, &c. *viz.* diminiſhing heat in proportion to the diminution of life.

If a lizard, or ſnake, when it goes to its autumnal hiding place, is not ſufficiently fat, the living powers become, before the ſeaſon permits it to come out, very conſiderably weakened, and perhaps ſo much as not to be again reſtored. If thoſe animals, in ſuch a ſtate, are expoſed to the Sun's rays, or placed in any ſituation which, by its warmth, would give vigour to thoſe of the ſame kind, which are poſſeſſed of a larger ſhare of life, they will immediately ſhew ſigns of increaſed life, but quickly ſink under the experiment and die; while others, reduced to the ſame degree of weakneſs, as far as appearances can diſcover, will live for many weeks, if kept in a degree of cold proportioned to the quantity of life they poſſeſs.

I obſerved many years ago, in ſome of the colder parts of this iſland, that, when intenſe cold had forced blackbirds or thruſhes to take ſhelter in out-houſes, any of thoſe that had been caught, and from an ill-judged compaſſion expoſed to a conſiderable degree of warmth, died very ſoon. The reaſon of this I did not then conceive; but I am now ſatisfied, that it was owing, as in the other inſtances, to the degree of heat being increaſed too ſuddenly for the proportion of life remaining in the animal.

From theſe facts it appears, that warmth cauſes a greater exertion of the living powers than cold; and that an animal, in a weakly ſtate, may be obliged by it to exert a quantity of the action of life ſufficient to deſtroy the very powers themſelves. (e) The ſame effects probably take place even in perfect health. It appears, from experiments made in a hot room, which were read to this Society, that a perſon in health, expoſed to a great degree of heat, found the actions of life accelerated ſo much as to produce faintneſs and debility.

If bed-cloaths are put over the perſon ſo as ſcarce to touch him, ſteam of volatile alkali, or of warm balſams and eſſential oils, may be thrown in, ſo as to come in contact with many parts of his body. It will certainly prove advantageous if the ſame ſteams can be conveyed into the ſtomach, as that ſeat of univerſal ſympathy will by theſe means be rouſed. This may be done by a hollow *bougie* and a ſyringe; but this operation ſhould be performed with all poſſible nimbleneſs, becauſe the inſtrument, by continuing in the mouth, may produce ſickneſs, an effect I ſhould chuſe to avoid. Some of the ſtimulating ſubſtances, which are of a warm nature, and have an immediate effect, may be thrown into the ſtomach in a fluid ſtate; *viz.* ſpirits of hartſhorn, peppermint water, juice of horſe-raddiſh; as many others alſo, which produce a more laſting *ſtimulus*, as balſams and turpentines, ſuch as are found to quicken the pulſe of a man in health; but the quantity muſt be ſmall, as they have a tendency to produce ſickneſs. The ſame ſteam and ſubſtances ſhould alſo be thrown up by the *anus*.

(e) It is upon this principle that parts mortify in conſequence of inflammation.

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The proceſs recommended under the firſt head of treatment ſhould ſtill be continued; while that recommended under the ſecond is put in practice, as the laſt is only an auxiliary to the firſt. The firſt, in many caſes, may ſucceed alone; but the ſecond without the firſt muſt, I think, always fail in caſes where the powers of life are conſiderably weakened. Motion poſſibly may be of ſervice, it may at leaſt be tried; but, as it has leſs effect than any other of the uſually preſcribed *ſtimuli*, it ſhould be the laſt part of the proceſs (*f*). I would recommend the ſame care to the operator in regulating the proportion of every one of theſe means as I did before in the application of heat; poſſibly every one of them may have the ſame property of deſtroying intirely the feeble action which they have excited, if adminiſtered in too great a quantity; inſtead, therefore, of increaſing and haſtening the operations on the firſt ſigns of returning life being obſerved, as uſually done, I ſhould wiſh them to be leſſened, that their increaſe afterwards may be graduated, as nearly as poſſible, by the quantity of powers as they ariſe. If the heart begins to move, I would leſſen my application of air to the lungs, and with great attention obſerve when the muſcles of reſpiration began to act, that, when they do, I might leave a great deal to them. I would by

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(*f*) How far electricity may be of ſervice, I know not; but it may, however, be tried, when every other method has failed. I have not mentioned injecting ſtimulating ſubſtances directly into the veins, though it might be ſuppoſed a proper expedient; becauſe, in looking over my experiments on that ſubject, I found none where animal life received increaſe.

all means forbid bleeding, which, I think, weakens the animal principle, and leſſens life itſelf, conſequently leſſens both the powers and diſpoſitions to action. I would avoid introducing any thing into the ſtomach, which ordinarily produces *nauſea* or vomiting, as that alſo will have a ſimilar effect. I would avoid likewiſe throwing any thing in by the *anus*, which might tend to an evacuation that way, as every ſuch evacuation alſo tends to leſſen the animal powers; of courſe, I have avoided ſpeaking of the fumes of tobacco, which always produce ſickneſs or purging, according as they are applied.

Whoever is appointed by the ſociety for the purpoſes of recovering drowned people, ſhould have an aſſiſtant, well acquainted with the methods intended to be made uſe off; that, while the one is going on with the firſt and moſt ſimple methods, the other may be preparing other means, ſo that no time may be loſt between the operations; and the more ſo, as the firſt will, in all caſes, aſſiſt the ſecond, and both together may often be attended with ſucceſs, though each ſeparately might have failed.

A proper apparatus alſo is as eſſentially neceſſary to the inſtitution, a deſcription of which I here annex. Firſt, a pair of bellows, ſo contrived with two ſeparate cavities, that by opening them, when applied to the noſtrils or mouth of a patient, one cavity will be filled with the common air, and the other with air ſucked out from the lungs, and by ſhutting them again, the common air will be thrown into the lungs, and that ſucked out of the lungs dicharged into the room. The pipe of theſe ſhould be flexible, in length a foot or a foot and a half, and at leaſt three-eighths of an inch in width; by this the artificial breathing may be continued, while the other operations, the application of the *ſtimuli* to the ſtomach excepted, are going on, which could not conveniently be done, if the muzzle of the bellows were introduced into the noſe. The end next the noſe ſhould be double, and applied to both noſtrils. Secondly, a ſyringe, with a hollow *bougie*, or flexible *catheter*, of ſufficient length to go into the ſtomach, and convey any ſtimulating matter into it, without affecting the lungs. Thirdly, a pair of ſmall bellows, ſuch as are commonly uſed in throwing fumes of tobacco up the *anus*.

I ſhall conclude this paper by propoſing, that all, who are employed in this practice, be particularly required to keep accurate journals of the means uſed, and the degrees of ſucceſs attending them; whence we may be furniſhed with facts ſufficient to enable us to draw concluſions, on which a certain practice may hereafter be eſtabliſhed.